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JP 080065975 A JP 050030716 A US 5332374 A

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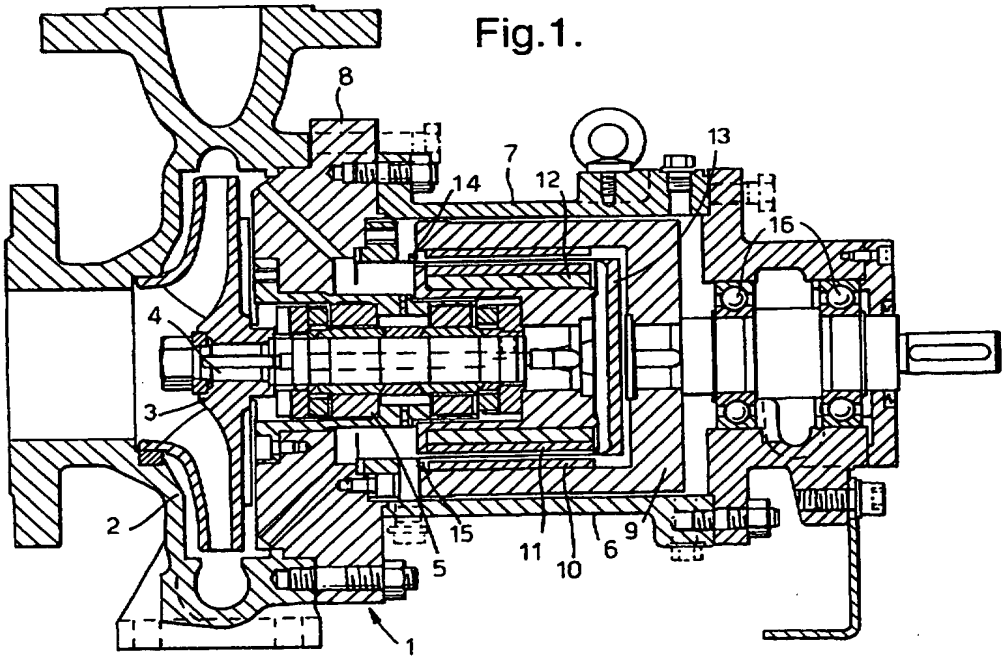
(54) Abstract Title
**A device for determining the axial position of the rotor in hermetically sealed drives.**

(57) The invention relates to a hermetically sealed drive system, particularly for pumps, comprising a magnetic field between a driving 9 and a driven rotating element 12, a stationary partition 13 being disposed between the driving and the driven rotating element and a sensor 14 generating an electric signal being positioned at the partition. One or more Hall-effect sensors 14 are disposed in the stray field of the permanently or electromagnetically connected parts.

Fig.1.

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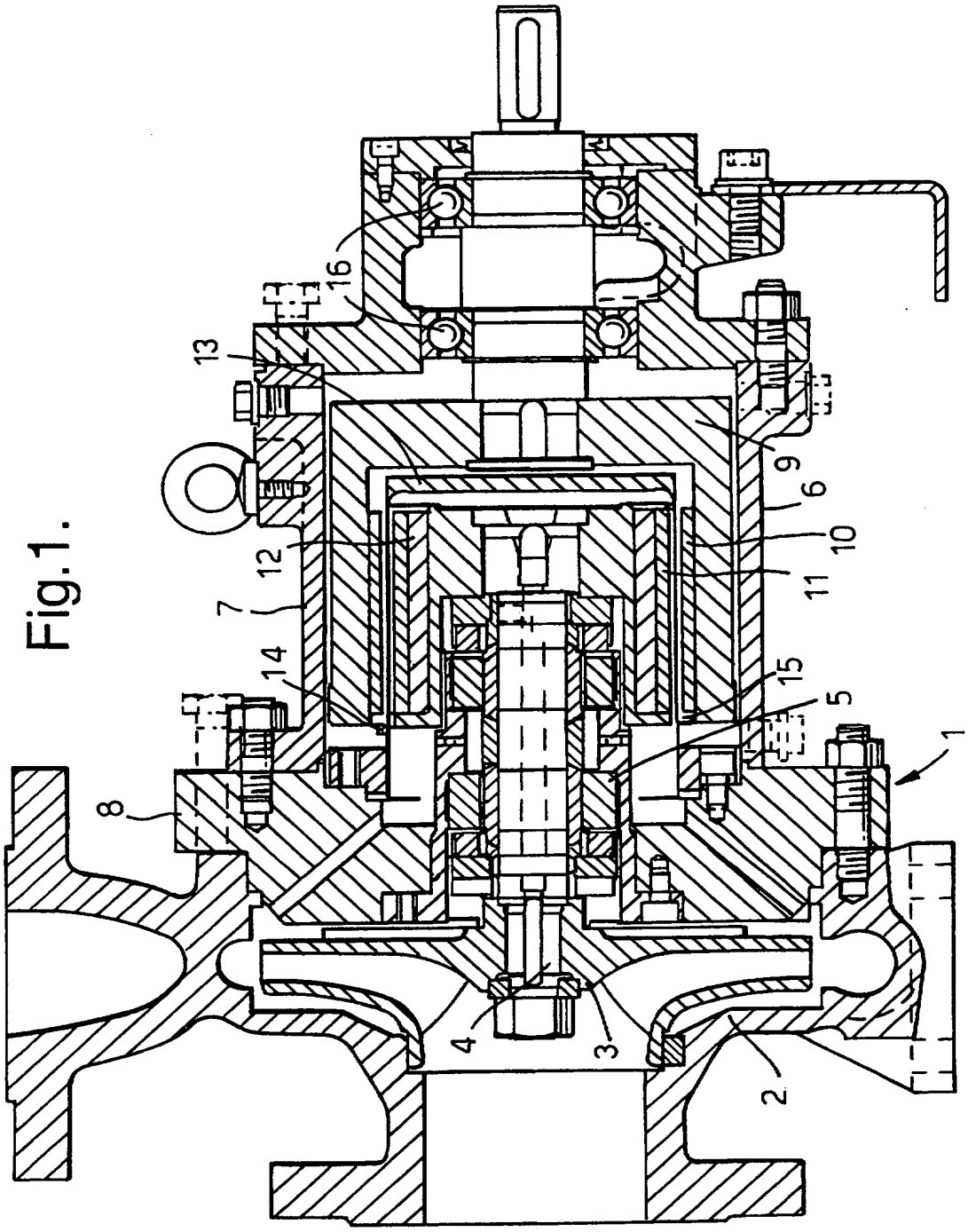
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.



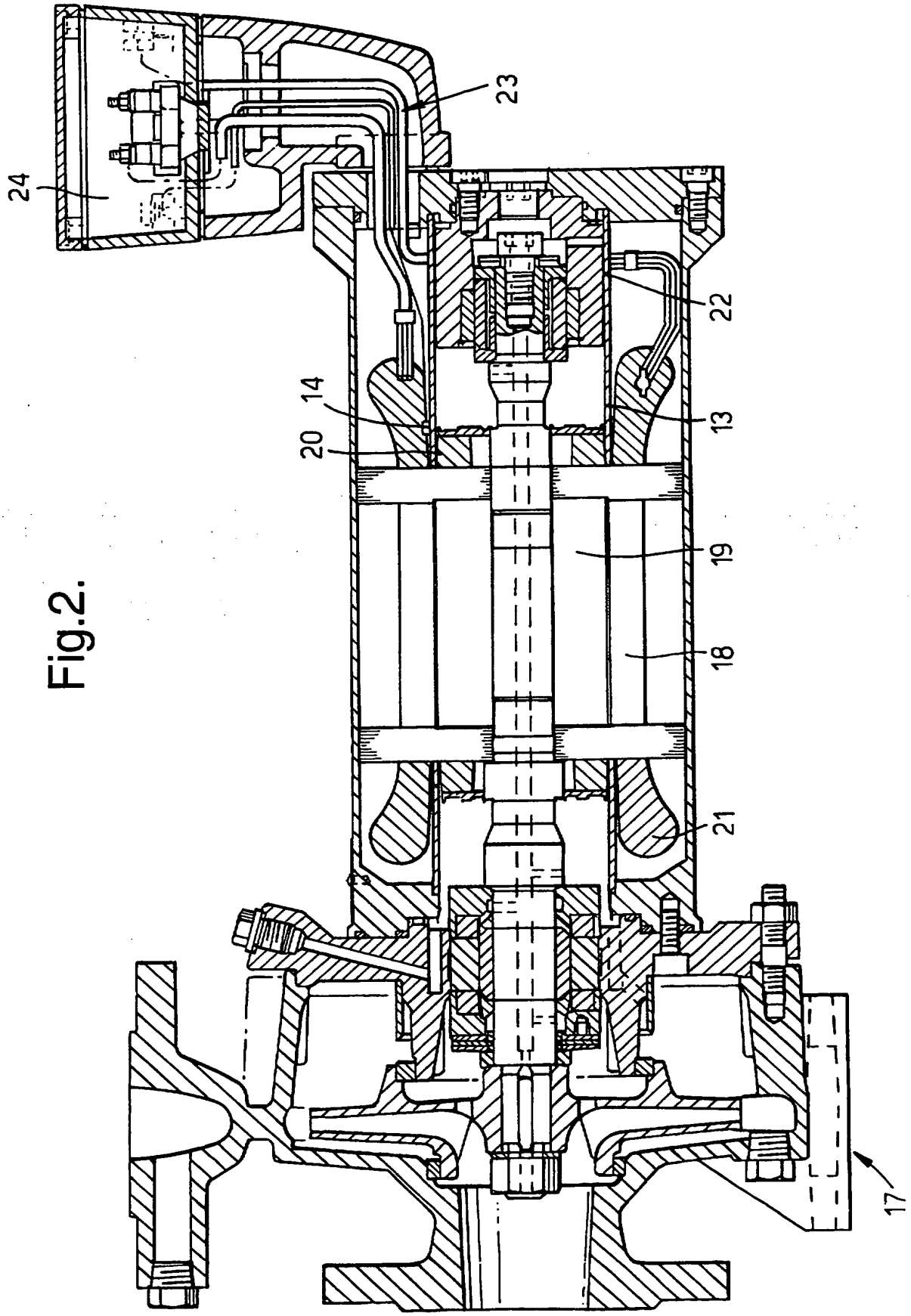



Fig.2.

Title of Invention:

**A device for determining the axial position of the rotor in hermetically sealed drives**

The invention relates to a hermetically sealed drive system, particularly for pumps, comprising a magnetic field between a driving and a driven rotating element, a stationary partition being disposed between the driving and the driven rotating elements and a sensor generating an electric signal being positioned at the partition.

There are various known methods of preventing damage to the partition between magnetically connected driving parts of this kind. The partition is a flat or pot-shaped component, depending on the construction.

DE-U 92 04 558 discloses a magnetic coupling pump wherein an outer force-transmitting rotor rotates around a partition in the form of a split pot and inside a stationary surrounding casing. In order to detect damage to the bearings, an inductive proximity switch is disposed in the casing bore and without contact, measures the distance between the rotating outer rotor and the casing bore. Any damage to the rolling bearings of the outer rotor will cause the rotor to wobble, thus changing its distance from the outer wall. The proximity switch is disposed in a butt collar on the outer casing, and the gap between the butt collar and the outer

rotor is less than the gap between the outer rotor magnet and the split pot. If therefore the bearing is suddenly damaged, the outer rotor will first run against the butt collar, not against the split pot. The proximity switch registers any change in the distance and switches off the motor.

US-A-35 12 904 discloses a magnetic coupling pump in a cooling system. Coils are disposed in a flat partition between the magnetic coupling parts and detect the magnetic flux. Based on the magnetic flux, the coils generate a monitoring signal which alters in characteristic manner if the non-positive connection between the magnetic coupling parts is disturbed. In this construction the thickness of the partition is over-dimensioned compared with other magnetic couplings. This is necessary for providing room in a portion of the partition for receiving an electric coil incorporated in the plastic substrate, so that the partition retains a uniform thickness. The disadvantage of this however is that the very thick partition impairs the transmission between the co-operating pairs of magnets. The coil incorporated in the partition can detect a "break" in the coupling, i.e. a state of operation where transmission of magnetic force between the co-operating components is no longer ensured. In this state of operation, the coil delivers an abnormal voltage signal, which is used to stop the drive.

US-A-5 332 374, in the case of a special construction of a magnetic coupling pump, discloses a flat partition and a Hall-effect sensor disposed in the region of the drive. The construction discloses a "disc armature" motor like a canned motor. A flat metal disc serves as a can and is disposed between a stator disc and a rotor disc. Force between the stator and rotor is transmitted by an electrodynamic field, which exerts a driving effect on a pump impeller equipped with magnets. A number of Hall-effect sensors for monitoring the motor are disposed in the stator in the hub region. In the hub region the sensors co-operate with specially constructed tips of the magnets rotating with the impeller.

In the Hall-effect sensors, the magnetic lines of force radiated by the special magnet tips generate a signal which is used by a monitoring device to monitor and change the speed of the motor. The monitoring device contains an additional programming means, which uses the measured pump speed to draw conclusions about the delivery rate of the pump.

In the case of canned motor pumps it is known from DE-A-35 38 225 to connect a number of receiver coils in series at the head of the stator winding. A permanent magnet disposed on and rotating with an impeller induces pulses in the receiver coils. This is a simple method of measuring the speed of the said motors.

DE-A-41 13 198 discloses a canned motor comprising a device for monitoring the bearings. To this end a cap containing vibration-sensitive sensors is disposed in the region of a motor bearing. The sensors register vibration of the bearings. Acceleration sensors such as piezo-ceramic or piezo resistive elements or piezo foils can be used to measure the wear in the axial and radial direction on the bearings of the electric motor shaft and pump rotor. Additional sensors in the form of components sensitive to magnetism detect the speed and direction of rotation of the electric motor.

The invention is based on the problem, in the case of hermetically sealed pumps, to develop a device for contactless determination of the axial rotor position without adversely affecting the performance of the drive and without increasing the thickness of the thin partitions disposed between the driving and driven elements. This problem is solved by the features in claim 1.

If a Hall-effect sensor is disposed in the region of a magnetic stray field at the end of the rotating elements, their axial movements relative to one another can be determined. The lower field strength around the scatter field is influenced by a change in position between the driven and driving rotor. The changed lines of force in the region of the stray field occurring at the ends of the co-operating magnetic parts weakens the magnetic field strength. This weakening is a measure of the axial

position or displacement of the rotors relative to one another.

The sensitivity of a Hall-effect sensor is selected in accordance with the respective magnetic stray field, i.e. the Hall-effect sensor is adapted to the field strength in the stray-field region. It can be disposed in the region of a magnetic stray field induced by permanent magnets or in the stray region of an electrodynamically induced field.

The device can also give information about the actual load on the magnetic coupling. The Hall-effect sensor fastened to the stationary partition can therefore also detect any displacements of the inner rotor. The partition itself is usually a component of a tubular split pot, since this construction permits transmission of larger forces. Alternatively it can be a flat wall surface between suitably shaped magnetic coupling parts.

To prevent changes in shape of a partition due to pressure or temperature being incorrectly interpreted as changes in the angle or position of a rotor, the deformation properties of a partition can be detected in very simple manner by experiments and, in the form of suitable characteristic values, can be taken into account when evaluating the measured results.

The tubular or disc-shaped partition, on which one or more Hall-effect sensors are disposed, can be

made of a wide variety of materials such as steel, fibre-reinforced materials or hybrid materials made up of various substances. A Hall-effect sensor can have any desired shape, preferably in accordance with the space available at the chosen place of installation. The place of installation is chosen so that operation of the partition, in the form of a static hermetic seal, is not adversely affected by the Hall-effect sensor.

The main advantage of this solution is that advantageous use is made of a property of the magnetic field, i.e. the stray field, previously regarded as negative and useless. If a Hall-effect sensor is disposed in the stray field and detects the change in the magnetic field due to a change in the lines of force, the position of the motor can be detected by a very simple construction. No special construction is needed for the partition or additional elements. Depending on its shape, a Hall-effect sensor can be attached to a wet or dry side of a partition. It has been found advantageous to dispose it on a dry side of a partition, since this avoids the need for special sealing of the cable ducts.

The speed can additionally be determined in very simple manner by using an electronic circuit for counting the pulses generated by the rotating magnetic stray field in the Hall-effect sensor. Various known evaluating circuits can be used for this purpose.

Exemplified embodiments of the invention are shown in the drawings and will now be described in further detail. In the drawings:

Fig. 1 shows a magnetic coupling pump in section, and

Fig. 2 shows a canned motor pump in section.

Figure 1 shows a single-stage magnetic coupling pump 1. An impeller 3 rotates in a pump casing 2. It is connected to a shaft 4 secured in a bearing 5. A magnetic coupling 6 is disposed at the end of the shaft 4 remote from the impeller 3. The magnetic coupling comprises an outer casing 7 connected for transmission of force to a pressurised lid 8 of the pump casing 2. A pot-shaped outer rotor 9 having a number of permanent magnets 10 disposed on its inner wall is positioned inside the outer casing 7. The permanent magnets 10 are operatively connected to permanent magnets 11 fastened to the outside of an internal rotor 12. The internal rotor 12 is disposed at the end of the shaft 4 opposite the impeller. The rotor 9 is fixed to a driving shaft (shown mounted in ball bearings), extending to a driving motor (not shown).

The hermetically sealed partition 13 in the form of a split pot is disposed between the internal rotor 12 and the external rotor 9.

In this embodiment a Hall-effect sensor 14 is disposed on the outside of the partition 13 in the region of the stray field of the permanent

magnets 10, 11. In the event of a change in the stray field caused by changes in the axial clearance in the bearing 5 of the internal rotor 12 or changes in the axial position of the shaft 4, the sensor 14 delivers a corresponding signal to an electronic device, not shown here. In an emergency the electronic device can use the signal to stop a motor driving the magnetic coupling pump 1, trigger an alarm or display information about the position of the impeller, thus also giving information about the axial thrust.

Fig. 2 shows a single-stage canned-motor pump 17. The electrodynamic field, likewise rotating in the gap between the stator 18 and rotor 19, likewise has a stray field in the region of the short-circuit rings 20 of the rotor 19. The Hall-effect sensor can therefore be disposed directly on the partition 13, in the form of a split tube here, or on a reinforcement 22 of the partition disposed in the region of the coil ends 21. In this embodiment the Hall-effect sensor 14 is in the region of the coil ends 21 remote from the pump. The advantage of this is that correspondingly short connecting lines 23 can simply be disposed in a terminal block 24 situated there. From there, the signal is delivered to a suitable electronic switching unit. In the event of impermissible axial movements of the rotor 19 exceeding the prescribed set values, an alarm can be triggered or the pump switched off.

By means of the Hall-effect sensor 14, a very positive effect is obtained from the part of a magnetic stray field previously regarded as useless, in that it is used to indicate axial changes in position of the rotating elements 4, 9, 12, 19.

CLAIMS

1. A hermetically sealed drive system, particularly for pumps, comprising a driving element and a driven rotating element, a stationary partition being disposed between the driving and the driven rotating element, the driving element being operable to produce a rotating magnetic field spanning said partition to drive the rotating element in rotation, the system including a sensor generating an electric signal being positioned at the partition, characterised in that one or more Hall-effect sensors (14) are disposed in the magnetic stray field of the rotating element (9, 12, 19).

2. A drive system according to claim 1, characterised in that at least one Hall-effect sensor (14) for detecting the axial motion of the rotating element (4, 9, 12, 19) is disposed in the neighbourhood of a stray field at the end of the magnetic field.

3. A drive system according to claim 1 or 2, characterised in that the Hall-effect sensor (14) is incorporated in the partition (13, 22).

4. A drive system according to claim 1, 2 or 3, characterised in that the Hall-effect sensor (4) is disposed on the partition (13, 22).

5. A drive system according to any of claims 1 to 4, characterised in that a Hall-effect sensor (14) disposed in the region of the magnetic field detects the speed of the rotating element (4, 9, 12, 19).

6. A drive system according to any of claims 1 to 5, characterised in that the Hall-effect sensor (14) is in the form of a sheet or plate fastened on or in the partition (13, 22).

7. A drive system according to any of claims 1 to 6 in which said driving element and said driven element are respective parts of a magnetic coupling, the driving element being in turn arranged to be driven by a motor.

8. A drive system according to any of claims 1 to 6 in which said driving element and said driven element are respectively the stator and rotor of a canned rotor electric motor.

9. A drive system according to claim 7 and substantially as hereinbefore described with reference to and as shown in Figure 1 of the accompanying drawings.

10. A drive system according to claim 7 and substantially as hereinbefore described with reference to and as shown in Figure 2 of the accompanying drawings.

11. Any novel feature or combination of features disclosed herein.

INVESTOR IN PEOPLE

**Application No:** GB 0031836.0
**Claims searched:** All

**Examiner:** Geoff Holmes
**Date of search:** 23 August 2001

# Patents Act 1977
# Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): G1N (NACNA, NACNE, NACW, NAFA, NAGB1, NAGC1, NAGD1)

Int Cl (Ed.7): G01B 7/14, 7/31; H02K 11/00; F04D 15/00

Other: Online: WPI, EPODOC, JAPIO

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|---|---|---|
| Y | JP 080065975 A [EBARA] | 1 at least |
| Y | JP 050030716 A [EBARA] | 1 at least |
| Y | US 5332374 A [KRICKER et al.] see figure 1 | 1 at least |

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